MAT-88-10

Rock Lake Stabilization

Soil Bioengineering Research Project – Phase 2

Hwy. #60, Rock Lake, Algonquin Park

Ontario

Ministry of Transportation

Research and Development Branch

Technical Report Documentation Page

Rock Lake Stabilization

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Hwy. #60, Rock Lake, Algonquin Park

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Abstract:	During the second year growing season, the soil bioengineering structure installed on Highway 60 at the Rock Lake site suffered considerable mortality of the living structures. Further investigation indicated that the mortality occurred in the fall of the previous year, but attempts to ascertain the cause were inconclusive. The report describes the function of both live and dead soil bioengineering structures in stabilizing the soil and in facilitating the colonization of the site by other plant species. Recommendations include the continued monitoring of the installation as well as some supplementary tests to investigate the effects of variables, such as nutrients, on overall success.
Comments:	The site will be monitored for an additional year. A second experimental structure will be installed in an adjoining area in 1988. (See Project No. 22201)
Key Words:	soil bioengineering, brush layering, live stakes, erosion control, slope stabilization
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MAT-88-10

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Landscape Architects

Soil Bioengineering Corporation,
Soil Bioengineers

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October 1988

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INTRODUCTION

The purpose of this report is to document the process of the site stabilization following the soil bioengineering installation in the spring of 1986 at Rock Lake. This review was to include monitoring soil stability, growth of the installed material (rooted and unrooted) and the colonization of the soil surface by other plant species.

As the review proceeded, it became apparent that many of the soil bioengineering structures which were alive the previous year were now dead or dying. In an effort to discover the cause, some additional investigation was initiated as to soil condition and the presence of insect or disease infestations.

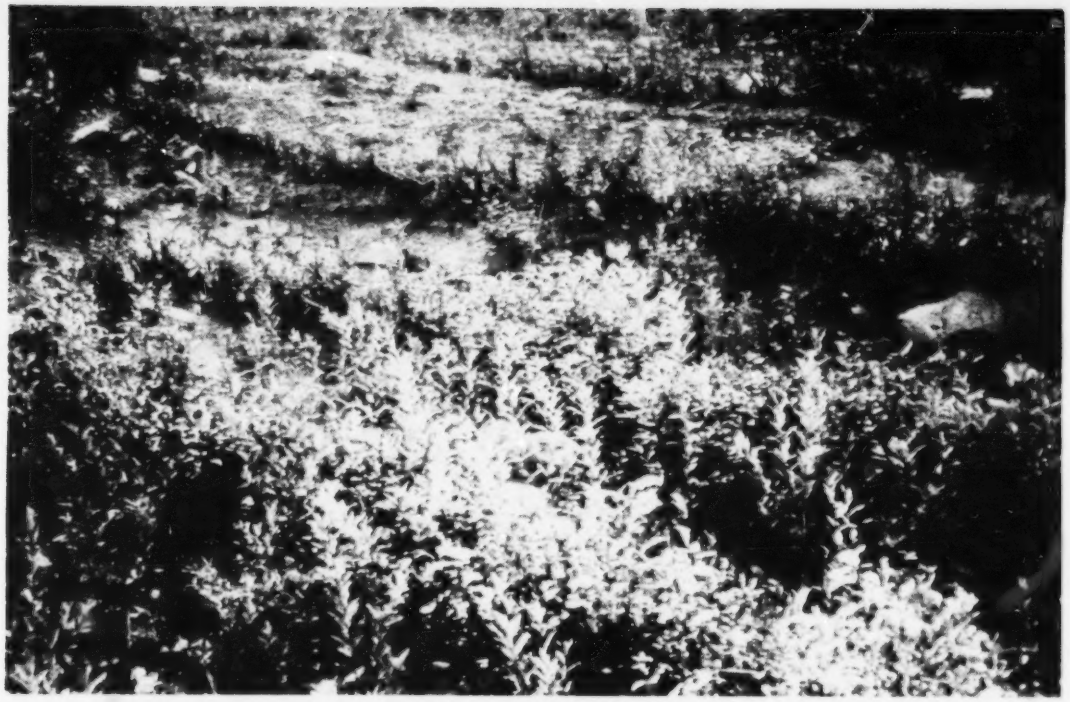
This report documents the progress of the site stabilization, summarizes the findings of these investigations and recommends further action.

GENERAL

Upon completion of the installation in 1986, five test plots were established to keep a photo record of the site's progress. These were photographed in June of 1986 (see photo #1) and indicate the growth of the soil bioengineering structures in the first two months.

Most of the structures show some growth with the lower areas being the most lush and the upper areas being sparcer and showing more stunted growth. It was originally thought that the poorer result in the upper slope was due to improper compaction upon backfilling, causing air pockets in the soil to dry the newly installed material. Preliminary review of the plant material indicated that the willows were the dominant successful plant with dogwood second. Poplars almost completely failed to grow. In some of the lower, perennially wet areas, alder (not expected to root) had taken root and was growing well.

The site was again reviewed in late winter (see photo #2) to observe the snow deposition on the site. The soil bioengineering structures were intended in part to hold snow on the site to reduce the number of annual freeze/thaw cycles. As shown, these were working quite well to maintain snow cover well into the spring thaw.



Picture No. 1/ Typical test plot 1986
First year's growth of soil bioengineering installation.

Picture No. 2/ Snow Deposition, Winter 1986-87
Snow deposited and held on the surface
by soil bioengineering structures.

June 1987

In June 1987 the site was reviewed, described and photographed (see Site Inspection Report #1.) At this time the escalating mortality of the plants on the upper slope was noted and it was realized that the five lower plots would not be indicative of the site in general, nor would they be effective in monitoring the general decline of the upper portion of the site. Accordingly, three test areas were established at random and photographed, representing each of the three major soil bioengineering systems on the slope.

Vegetative growth and root systems were observed and measured in various soil bioengineering structures (photos #3 & 4). This investigation yielded no conclusive cause of the plant mortalities. It was noted that many plants which had ample root systems and top growth the previous year had not leafed out in the spring of 1987. Some, which showed partial spring growth, had large areas of dead cambium when the bark was removed.

Soil samples were taken for analysis and samples of dead material were submitted for testing for disease or insect problems.

The extreme lower portion of the site, where soil was continually moist, continued to develop well. The soil bioengineering installation grew well and the spaces between the structures colonized quickly with perennial ground covers.

Test results gave no indication as to what had caused the continued deterioration of the plants on the slope. The soil was deficient in nutrients, as we knew, but not so much so that it should cause plant failure. No leaf discolouration was noted on live plants which would indicate a severe nutrient deficiency.

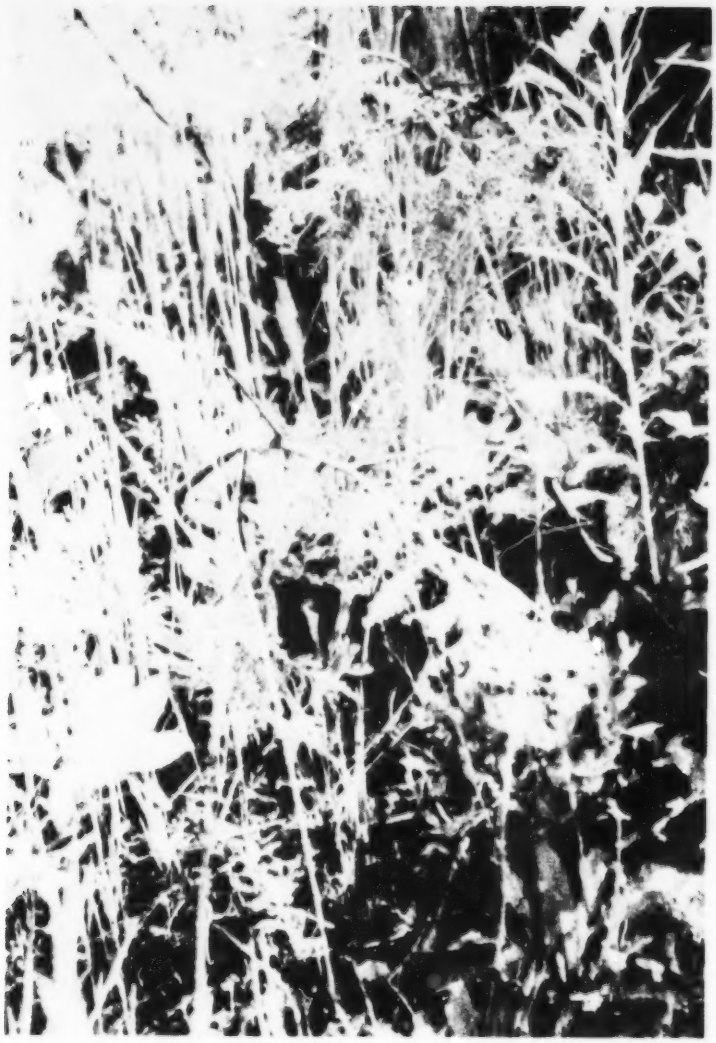
The obvious answer, that the plants had succumbed to drought on the dryer upper soils, was discounted for two reasons. Firstly, seedlings with very small root systems had survived adjacent to dead live stakes with substantial root systems and secondly all indications were that most of the plants had died or begun to die in the fall of 1986 which was moist and temperate.

July 1987

The site was again reviewed in July 1987 (see Site Inspection #2). During this inspection it was noted that the mortality was continuing through the top of the site with almost all of the soil bioengineering structures now dead. Colonization of the upper slope was very slow or non-existent. We suspect that most of the herbaceous groundcovers were remnants of the original slope vegetation growing from surviving root stock. The lower portion of the site continued to flourish with a thick groundcover developing (see photo #5). Also in this photo, note the cedar branch which continues to live where it was placed in the soil. Investigation showed that it had not grown at the tip and had only established a 5mm long rootlet, but it has apparently continued to survive in the damp soil.

Picture No. 3/ Typical Rooting - Live Fascines with Brush Layer
Showing mid-slope root and leaf growth, spring 1987 (2nd year).

Picture No. 4/ Typical Rooting - Live Stake
Showing lower mid-slope root and leaf growth, spring 1987 (2nd year).
Note several dead shoots and poor bud break.



Picture No. 5/ Typical Groundcover - Lower Portion of Site

Note the diversity of herbaceous invaders and the live cedar twig.

September 1987

The site was again reviewed in September 1987 (see Site Inspection #3). Very little had changed on the site with regard to the plant material. Some of the rooted viburnums were beginning to show signs of stress but it is not certain if this was just due to the cool weather prior to the inspection. However, the soil surface throughout the upper slope was beginning to show signs of rill erosion due to surface runoff. The control portion of the site, planted only with rooted viburnum had not changed significantly.

Finally, the cutting sites were visited to see if the parent stock was showing any signs of stress. Both the willow and dogwood showed excellent new growth with no signs of dieback or disease.

DISCUSSION

The results of this year's site review have been, for the most part, inconclusive.

We know that there were problems with soil compaction during the installation, that plants which grew well through the first summer died or began to die at the end of the first growing season, and that there were unusually prolonged droughts in both the first and second growing season. We also know that there have been no substantial changes in those elements commonly measured in soils tests since construction and that disease or insects did not play an important role in mortality of plants on the site.

One thing which appears certain is that the upper slope will continue to deteriorate and erode unless something is done to prevent it. We suspect that surface soil movement has prevented seed germination since the installation and that the rill erosion will expand unchecked without the stabilizing effects of a surface groundcover.

The surface erosion could be controlled if the site was hydroseeded soon to establish a uniform, herbaceous ground cover across the slope. It is doubtful, however, that this would solve the long term problems which the soil bioengineering structures were meant to control. In addition, this would eliminate the possibility of further monitoring of the natural development of the site.

There are other concerns which mitigate against attempting to seed the slope. First of all, it is uncertain as to what has caused the mortality of the live plants installed on the site. We can therefore not tell if the lack of colonization of the upper site is a result of the failure of the soil bioengineered material or of some other, undiscovered, condition in the soil, such as fertility, toxins, light levels or drought. If the latter is the case, the re-seeding will be simply a waste of money. In addition, the stabilization of the soil surface has been attempted in the past with success, only to have the site deteriorate and fail as time progresses.

In the final analysis, the decision as to whether or not to seed should probably be based upon whether the goal of this project is soil stabilization or scientific research.

There are several other questions which remain unresolved such as,

1. Will a dead soil bioengineered structure continue to stabilize the slope and promote natural regeneration? and, if so,

2. How well will that plant material establish itself on the site?

3. Are different species of poplar, dogwood and willow better for soil bioengineering on this site?

4. How important is soil moisture to success?

5. Would fertilizer have improved success and, if so, which mixtures would be best?

6. Did slope orientation affect success?

7. Is the age of material cut important to success?

8. How long does improper installation continue to affect success?

It would seem prudent to attempt to answer these questions before deciding on any further action on the slope.

RECOMMENDATIONS

1. Understanding the sequence of events which follow a failure is very important in making decisions about what, if any, remedial action should be taken and when. It is also important to understand the effects of failed structures and the resultant soil conditions on adjacent, successful installations and to consider when a remedial action is necessary.

   We therefore recommend that the site monitoring of the existing installation continue through the next growing season.

2. The question of whether surface seeding would be effective in stabilizing the soil surface in an area where soil bioengineering has failed remains unresolved. Although we feel that the progress of the site should be reviewed, we also feel that limited testing of remedial work on a failed structure would answer many questions about the site.

   We recommend that two minor test plots within the site be seeded with a grass/legume mixture and the results monitored for comparison with the remainder of the site.

3. The answers to many of the outstanding questions mentioned earlier are important to further our understanding of soil bioengineering in this climate and on this site. The answers to many of these questions are beyond the expertise of our firm. In addition, the length of time between the installation and the coming season and the lack of detailed original data (ie., plant species) makes some testing ineffective.

   We recommend that a programme of test installations be designed and implemented by a team of experts including a soil bioengineer, botanist and landscape architect to attempt to discover the reasons for the original failure, the relative effectiveness of adding such elements as fertilizers, the relative success of various species and cultivars of plant materials, the relative success of new growth cuttings compared with old growth cuttings.

SITE INSPECTION Friday, June 6th, 1987 **# 1**
11:30 a.m. to 4:30 p.m.

Weather

Sunny with cloudy intervals, light breeze from the north-west. Soil moist after two weeks of intermittent rain and thunder storms which followed a five week drought.

Site Conditions

- Colonization/invasion by herbaceous plants was almost complete in lower (perennially wet) areas.
- Colonization in upper (dryer) areas of the site was not very extensive. Some woody seedlings (eg. poplar) have established themselves throughout the site, very sporadically. These may have been remnants from original vegetation.
- Almost all of the successful vegetation in the dryer (upper) areas of the site have died back or died completely.
- Many stakes showed considerable dieback and some of last year's shoots had not yet broken bud in sections which were still green.
- Much of the new growth on the willows had been severely damaged by caterpillars with no similar damage noted on original, established willows or poplar, or on the dogwood.
- The rooted stock planted throughout the site was doing very well. No signs of dieback.

Site Investigation

- Three live stakes, one area of vertical brushlayering and one area of live fascines were excavated to look at their root systems.
- Of the three live stakes, one was growing well (in the lower, moister area), one showed 50% mortality of last year's growth and one showed complete mortality of last year's growth.
- The vertical brushlayer reviewed was doing well in the low area of the site on the west end (the last to be installed).
- The live fascine was part of a combination brushlayer/live fascine which had showed new growth of $^{+}/_{-}$ 150mm last year and now showed complete mortality.

Live Stakes

1. The first stake to be reviewed was growing well in the lower, moister part of the site. It displayed 150-200mm of new, healthy top growth with no dieback. On excavation, a healthy, vigorous root system was evident, showing new growth on all areas. Roots averaged 150-200mm in length and were growing from all subsurface areas of the stake.

2. The second stake reviewed was installed part way up the slope in fine soil. It displayed good growth from two of the six shoots which had sprouted last year, the others being dead. On excavation, the complete fibrous root system throughout the underground portion of the stake was found to be completely dead. Growth had been an average of 150-200mm with some roots in excess of 600mm long. Peeling the upper bark showed that the cambium had died around approximately 75% of the stake in all areas except where the two live shoots were growing.

3. The third stake was installed part way up the slope in coarse, sandy soil. Although growth in the previous year was good, the stake was completely dead, showing no new shoot development. On excavation, the complete fibrous root system throughout the entire underground portion of the stake and extending 150-200mm in length was found to be completely dead. No green cambium growth was found on the stake.

Vertical Brushlayers

The vertical brushlayer reviewed was at the toe of the slope in moist to wet soil. The branches displayed good leaf growth of willow and dogwood without signs of dieback. On excavation, a healthy root system was found near the surface and at the ends of the branches, however a large void area was unearthed which had precluded root growth in the middle section. Root growth averaged 150-200mm with some roots in excess of 600mm. Roots extended in all directions.

Live Fascines

The live fascine reviewed showed shoot development from the fascine and the stakes used to secure it last year, but all were dead this year. On excavation of the fascine, roots of approximately 100mm were found in the soil but all were dead as well. The entire inside of the fascine was void of soil.

Notes

Soil samples were taken from material excavated from around the two upper stakes and analyzed. Both showed improved soil conditions from the original soils tests.

Samples of the willow which died after growing the previous year were sent for analysis as to the cause of the mortality.

Sample areas were staked in to observe the colonization of the soil surface by invasive plant species. To date, the major portion of the site shows healthy regrowth of original plant species which had survived the construction or colonized the site last year and were regrowing from root stock. The site will be monitored to record the invasion of new species.

SITE INSPECTION July 10, 1987 # 2
10:00 a.m. to 2:00 p.m.

Weather

Sunny, hot and humid. Breeze from the north-west. Soil moist with slight seepage from the main drain.

Site Conditions

- No additional surface erosion noted, the rill erosion noted in the west side has stopped and is being colonized. (also see Area 2)
- Colonization/invasion by herbaceous plants was complete in the lower (perennially wet) areas consisting predominantly of grasses.
- The upper areas of the site show some limited colonization by herbaceous and woody plant material.
- Herbaceous plants show signs of good seed production.
- The rooted stock is still doing very well although it has exhibited limited growth this year.
- The site has a general lush green appearance in the lower areas which deteriorates to mostly sandy and barren in the upper areas. The green of the rooted material keeps the site from looking entirely devoid of vegetation at the top.

Site Investigation

Live Stakes

This year's growth to date on live stakes averaged 150mm with a maximum of 500mm. Most of those which were suffering in the spring have died completely.

Brushlayers

This year's growth to date on brushlayered material has averaged 100mm on willows and 50mm on dogwoods. Most of the material which was suffering at the last inspection has now died completely.

Live Fascines

This year's growth to date on live fascine material has averaged 100mm.

Cedar

The cedar log laid up the slope at the west end of the site has died completely. However, the cedar branches placed in the moist soil (lower central area of the site) are still green. On excavation some very limited growth (2mm) was evident at the broken end of the branch.

Three areas of the site staked in the spring were photographed and described.

Area 1 Central Spine and Live Stakes

- Good growth on live stakes was noted with 150-300mm this year and total growth of 400-600mm.
- Good infilling of herbaceous material has begun with 10% of the area in grasses and 30% in other herbaceous perennials. These are clustered next to the brushlayers.
- One new birch seedling was noted along with several birch and willows which had survived through construction.

Area 2 Vertical Brushlayer

- The area is very dry with no regeneration.
- Only the rooted cuttings are growing in the brushlayer.
- A minor rill has formed through the area and is extending through the lower brushlayer.

Area 3 Live Fascine/Brushlayer

- Some growth on live stakes is noted with good viburnum (rooted cutting) growth.
- No growth exhibited on the live fascine.

Comments

Results of soil tests, Appendix #1, show the soil is nutrient poor but with acceptable pH for plant growth.

Results of testing for disease and insects, Appendix #2, indicates that material died in the fall of 1986. It is speculated that the hot dry weather in the spring of 1986 and 1987 was very hard on the plants in the upper, dryer sections. This, coupled with the poor compaction of soil around the stems during construction, stressed the plants so that growth utilized existing reserves of moisture and carbohydrates and then the plants failed. This would also explain why the larger diameter material (live stakes) with more reserves held on longer, while some of the thinner (brushlayered) material died quickly.

SITE INSPECTION Monday, September 14, 1987 **# 3**
11:30 a.m. to 4:00 p.m.

Weather

Sunny and cool with light clouds. Soil moist with moderate seepage from the main drain.

Site Conditions

- The site is still generally stable, although surface erosion in the form of small rills is starting to appear in some areas along the upper part of the site.
- Herbaceous plants were beginning to die back due to the advancing season. Several nights in the weeks preceding have had frost warnings.
- Colonization by herbaceous plants remains unchanged since July with complete cover in the lower, moister areas and sparse cover in the upper, dryer areas.
- Colonization of the upper slopes tends to be confined to sheltered areas adjacent to soil bioengineering and large rocks or on flatter areas.

Site Investigation

No significant new growth has appeared in soil bioengineered plant material since July. Similarly, there has been little further dieback on these plants since July.

The rooted material planted at the top of the slope is beginning to show some signs of weakness and dieback.

The three areas of the site staked out in the spring were again photographed and described.

Area 1 Central Spine and Live Stakes

- Soil coarse to fine with stones and boulders up to 500mm.
- Sporadic growth consisting only of willows in the soil bioengineering.
- All live stakes in the central spine have died except for one near the bottom of the area.
- To the west of the spine there are 8 live stakes of which 5 are doing well, 2 are suffering and one is dead.

Area 1 (Continued)

- Weed and grass invasion is good next to the central spine especially in the shelter of the branches. Weed growth consists mainly of hawkweed which was common on the site prior to the installation.
- 1 crown vetch plant was noted growing in the plot.
- 1 viburnum (rooted stock) in the plot was growing but had relatively small leaves.
- Some erosion (a small rill) was noted coming out of the brushlayer/live fascine combination.

Area 2 Vertical Brushlayer

- Fine, silty soil with stones and boulders up to 500mm in diameter.
- No growth was noted in the vertical brushlayer. In the brushlayer along the lower end of the plot, only the rooted material (viburnum and dogwood) had survived.
- Colonization of the slope was almost non-existent with only one small plant (hawkweed) growing in the plot.
- Erosion through the plot in the form of a small rill is becoming progressively worse.

Area 3 Live Fascine/Brushlayer

- Soil in this area is coarse to medium sand with pebbles up to 8mm. Coarser material is in the lower part of the plot.
- One sprig of the brushlayer, approximately 200mm long, remains alive. Five live stakes, all of which had first year growth are now completely dead.
- 3 viburnum (rooted) within the plot are still alive with one growing very well, one doing poorly and one very poorly.
- Some sporadic colonization of the soil surface has taken place, consisting of 2 tufts of grass, small areas of star moss (which are doing poorly) 1 birch seedling (remaining from the original slope) and approximately 6 assorted weeds.
- No surface erosion was noted in the plot.

AGRI-FOOD LABORATORIES
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Unit 1 503 Imperial Road Guelph Ontario N1H 6T9

RECEIVED JUN 2 4 1987

SOIL TEST REPORT

Ontario Ministry of Agriculture and Food

	DAY	MO.	YR.
SAMPLE RECEIVED	17	06	09
RESULTS REPORTED	17	06	18

SAMPLE NO	CROP TO BE GROWN (USUALLY A CHANGE IN CROP REQUIRES A CHANGE IN FERTILIZER)	FERTILIZER REQUIREMENTS † LIMESTONE TONNE/HA	NITROGEN KG/HA N	PHOSPHATE KG/HA P_2O_5	POTASH KG/HA K_2O	MANURE RATE †† TONNE/HA	MANURE RATE †† M³/HA	SOD ††	SOIL TEST VALUES AND RATINGS FOR CROP SPECIFIED: PHOSPHORUS SOIL TEST	PHOSPHORUS RATING	POTASSIUM SOIL TEST	POTASSIUM RATING	SOIL pH	BUFFER pH	MAGNESIUM SOIL TEST	MAGNESIUM RATING	MANGANESE SOIL TEST	MANGANESE RATING	ZINC SOIL TEST	ZINC RATING	Ca.	TEXTURE
PHOSPHATE AND POTASH FERTILIZER REQUIREMENTS ON THIS REPORT BASED ON ONTARIO RESEARCH WILL PROVIDE HIGHEST ECONOMIC RETURNS WHEN CROP MANAGEMENT IS ABOVE AVERAGE.																						
	New Nursery Stock	0		120	120				6	L	27	L	7.3		26	M	13		15		1001	C
	New Nursery Stock	0		120	130				6	L	13	L	6.9		4	L	13		16		111	C

WHEN MAGNESIUM SOIL TESTS ARE LESS THAN 20. APPLICATION OF MAGNESIUM IS RECOMMENDED FOR ALL CROPS. DOLOMITIC GROUND LIMESTONE IS THE BEST SOURCE WHERE SOIL PH IS BELOW 6.5. AT HIGHER PH VALUES APPLY 30 KG SOLUBLE MAGNESIUM PER HECTARE.

IF YOU HAVE APPLIED MANURE SINCE THE LAST CROP WAS HARVESTED OR INTEND TO APPLY MANURE YOUR FERTILIZER REQUIREMENTS SHOULD BE REDUCED AS DESCRIBED ON THE BACK OF THIS FORM.

† 100 KG/HA = 90 LB/AC.
10 TONNE/HA = 4.5 TON/AC.

†† MANURE AND SOD ADJUSTMENTS ARE EXPLAINED IN GREATER DETAIL ON BACK OF FORM
LIQUID MANURE RATES ARE IN CUBIC METRES/HA. SOLID MANURE RATES ARE IN METRIC TONNES/HA

A-FL-41-301

HARRINGTON & HOYLE LTD.
10 WASHINGTON ST
MARKHAM, ONTARIO

L3P 1R2

IF FURTHER ASSISTANCE IS REQUIRED, CONTACT

HORT CROP ADV. (416) 878-2314
17 WILSON DR
MILTON ONT L9T3J7

EXPLANATION OF YOUR SOIL TEST REPORT

SOIL TEXTURE refers to soil particle size as follows: coarse textured – sands and sandy loams, (C); medium textured – loams and silt loams, (M); fine textured – clays and clay loams, (F); organic – peat or muck, (O).

PHOSPHORUS AND POTASSIUM RATINGS of a soil test are chosen from the following range: L (low), M (medium), H (high), VH (very high), E (excessive). Each rating is for the particular crop specified. For instance, a soil test value rated medium for oats would be a low value for potatoes which have a higher fertility requirement. Excessive (E) ratings may cause reduced yields or quality of crops or pollution of water. Potassium is at the "excessive" level naturally in a few clay and clay loam soils but is not expected to cause problems in these particular soils because soils naturally high in potassium are usually high in magnesium.

SOIL pH is a measure of acidity or alkalinity, with pH values above 7.0 being alkaline and below 7.0 being acid. A pH of 7.0 is neutral. In Ontario many crops grow well on soils with pH values from 6.0 to 8.0.

REQUIREMENTS. The columns under requirements, which are the shaded area of your report, give the amount of fertilizer nutrients and lime required per hectare for the crop to be grown at the soil test value indicated. These requirements have been determined by fertilizer trials on Ontario farms, and are intended to produce highest economic yields when accompanied by above average management.

If you decide to change crops or management factors, consult Field Crop Recommendations, Publication 296, or Vegetable Crop Recommendations, Publication 363.

If you have used or intend to use manure but did not list it on the information sheet your recommendations will be quite unsuitable. This can be corrected by applying the adjustments shown below.

REDUCTIONS IN FERTILIZER REQUIREMENTS FOR MANAGEMENT FACTORS

MANURE APPLICATIONS*

CLASS OF LIVESTOCK	SUBTRACTED FROM FERTILIZER REQUIREMENTS NITROGEN - Kg / ha FALL OR WINTER	SPRING	SPRING** INCORPORATED	PHOSPHATE P_2O_5-kg/ha	POTASH K_2O-kg/ha
LIQUID MANURE at 10 cubic metres / hectare (one cubic metre = 220 imp. gals; one cubic metre / hectare = 90 gal/ac.)					
CATTLE	5	10	12	4	16
SWINE	8	15	19	7	14
POULTRY	23	46	58	22	26
SOLID MANURE at 10 tonnes / hectare (66 bu or 2.40 cu metres solid manure weighs approx. 1 tonne; 10 t/ha = 4.5 ton / ac.)					
CATTLE	12	24	30	10	44
SWINE	15	30	38	20	26
POULTRY	70	140	175	75	98

* THESE ADJUSTMENTS ARE BASED ON SLIGHTLY BELOW AVERAGE QUALITY MANURE.

** SPRING INCORPORATED MEANS INJECTED OR COVERED WITHIN ONE DAY OF APPLICATION.

SOD PLOUGHED DOWN

CODE NO	TYPE OF SOD	SUBTRACTED FROM NITROGEN REQUIREMENT NITROGEN (N) kg/ha
1	less than 1/3 legume	0
2	1/3 to 1/2 legume	55
3	1/2 or more legume	110
4	legume seeding ploughed same year	20

FOREST INSECT & DISEASE SURVEY SAMPLING FORM

1. INSECT 2. DISEASE

LOCATION

- COLLECTION POINT (be specific): about Trail
- NEAREST POST OFFICE: Whitney
- LOCALITY (use Forest Dist. or Div. or Drainage Div. or Political Sub-Div. or FIDS Dist.): Algonquin P. Sproule T
- UTM GRID DESIGNATION: 1770305
- 510
- PLOT OR SAMPLE AREA NO.:
- ELEVATION:

STAND EXAMINED

- DESCRIPTION: 2. Ornamentals (circled)
- HISTORY: 1. Undisturbed (circled)
- ASPECT: 1. North (circled)
- MATURITY: 3. Seedling (forest) (circled)
- AGE STRUCTURE: 3. Uneven (circled)
- BASAL AREA (Circle code of nearest no. of sq. ft.): 1. (33) (circled)
- FOREST SECT.: 705
- COVER OR SUB-TYPE: 9400
- DOMINANT SPECIES: 1
- HEIGHT OF DOMINANT TREES (Circle code of nearest ht. in ft.): 1. (0.5) (circled)

TREES SAMPLED

- TREE SPECIES: w
- NO. OF TREES SAMPLED: 4000 1
- STATUS: 2. Rec. dead standg. (circled)
- TREE CLASS:

DATA ON INSECT(S) OR DISEASE(S)

- SAMPLING TECHNIQUE, Qualitative: 2. Hand picked (circled)
- POPULATION LEVEL OR INCIDENCE: 5. High (circled)
- COLLECTION SOURCE: 8. Stem (circled)
- SAMPLE UNIT NO. / NUMBER OF UNITS: 00
- COUNT PER UNIT / AV. COUNT: 000
- DAMAGE & HAZARD INDEX:

GENERAL

- FIDS NO. (See codes on cover): 79066
- LANDOWNERSHIP (See codes on cover): 0
- DAY: 10
- MO.: 04
- COLLECTOR: I. [illegible] !!
- ADDRESS: What killed it and when?
- REMARKS & SYMPTOMS: ∴ 65 000 spent on experimental planting to stu[illegible] soil along the Hwy. Trees where bundled and buried except for these site. Others were simple pushed into the ground. It was very dry when they planted last ?2

81	5	0426	DISEASE COLLECTIONS	(Office use only)

SPEC NO	DISEASE	SPECIES CODE	STAGE	SYM	SYM	BI	Id	D	
01	SUBSTRATE			02	03		4	3	Can't give you a good answer. Trees died last fall. Those that grew probably had enough going for them to get one year before adverse site did them in. Some may have lived over winter but did not have enough to initiate spring growth

INSECT COLLECTIONS (Office use only)

SPEC NO	INSECT	SPECIES CODE	E	L	P	A	NO INS	Id	D